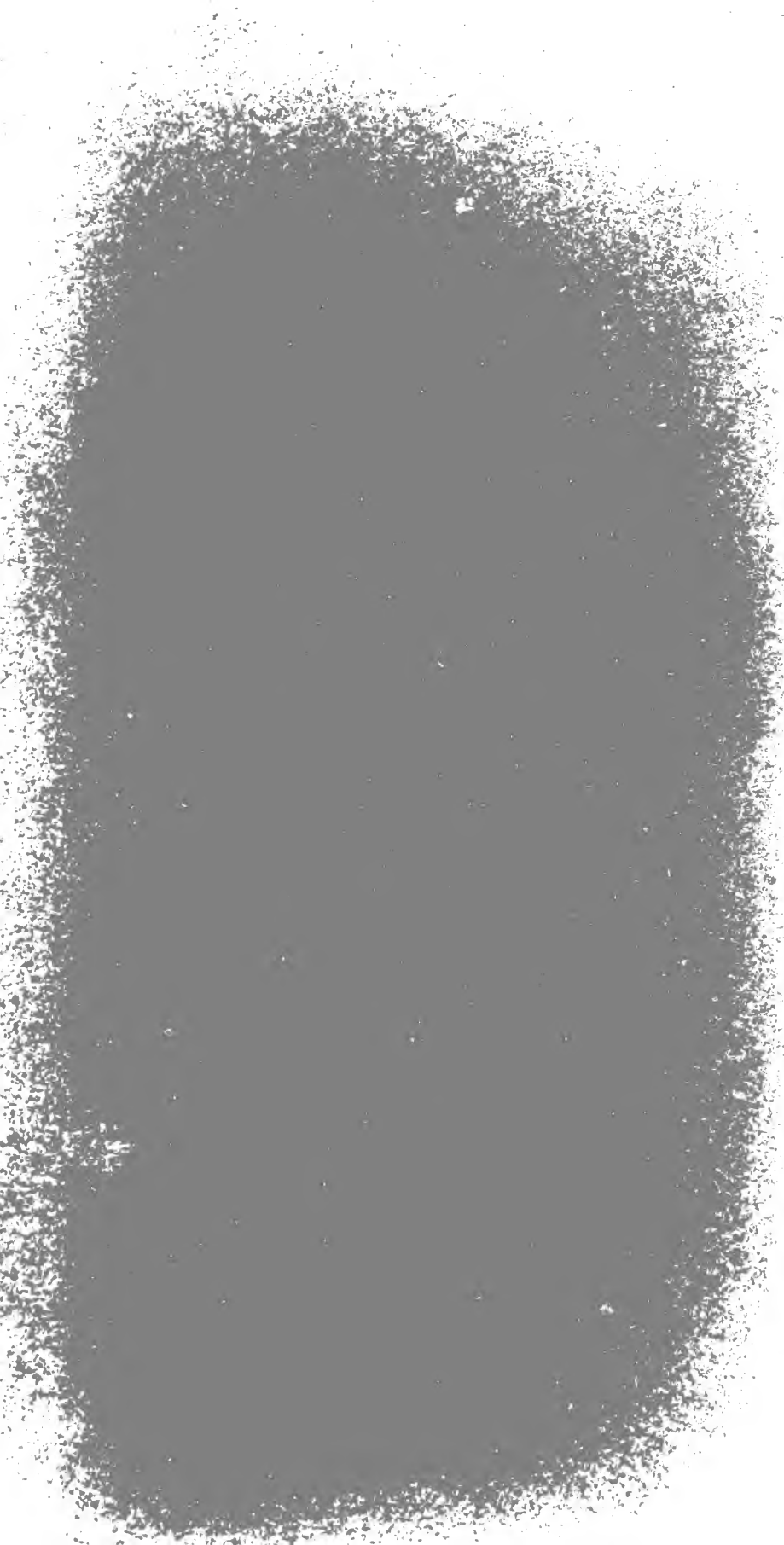
Stevens, John, 1749-1838
Stevens, Robert Livingstone 1787-1856
Stevens, Edwin Augustus 1795-1868

by

Watkins, John Elfreth, 1852-1903



JOHN STEVENS,
Inventor. Statesman.

ROBERT L. STEVENS,
President and Chief Engineer Camden and Amboy Railroad.

EDWIN A. STEVENS,
Manager Camden and Amboy Railroad.

JOHN STEVENS AND HIS SONS

EARLY AMERICAN ENGINEERS

BY

J. ELFRETH WATKINS

READ BEFORE THE PHILOSOPHICAL SOCIETY OF WASHINGTON, MAY 7, 1892

WASHINGTON:
PRESS OF W. F. ROBERTS
1892

BIOGRAPHICAL SKETCHES.

JOHN STEVENS AND HIS SONS.

Early American Engineers.

Biographies are too often eulogies. Yet it seems impossible to trace the career of John Stevens and of his sons (Robert Livingston and Edwin Augustus) without, apparently at least, joining the ranks of the hero worshipers—for I know of no other instance where a father and his sons have left behind them such a remarkable record of usefulness.

JOHN STEVENS.

John Stevens, the father, who was among the greatest engineers and naval architects living at the end of the last century, was born in New York of English lineage in 1749. He was graduated at King's College (now Columbia) 1768: was admitted to the New York bar in 1771: was treasurer of New Jersey during the active period of the Revolutionary War: and in the succeeding sixty years resided in New York and on his estate in Hoboken.

"Throughout this long period he labored continuously for the introduction and application of steam to navigation and to railroad locomotion."

John Stevens' attention was first attracted to steam-boat navigation while driving along the banks of the Delaware River near Burlington, N. J., when he saw in 1787, John Fitch's steam-boat pass up the river against the tide. His interest was so much excited that he followed the boat to its landing, where he examined the engines and the mechanism of the pushing paddles carefully. "From that hour he became a thoroughly excited and unwearied experimenter in the application of steam to locomotion." It was in this year that the Legislature of New York granted to Fitch the exclusive right to navigate the waters of that State with steam propelled vessels.

It was on the petition of John Stevens that the patent law of 10th April, 1790—the foundation of the American patent system—was framed. (See Journal of House of Representatives, p. 30.)

"In 1792, he took out patents for propelling vessels by steam-pumps, modified from the original steam-pumps of Savary. He made many experiments on different modes of propulsion by steam, having as his associates the elder Brunel, constructer of the Thames Tunnel, Chancellor Robert L. Livingston, his brother-in-law, and Nicholas J. Roosevelt. In 1798 he constructed a steam-boat that navigated the Hudson.

[Note.—The Author desires to acknowledge his indebtedness to Francis B. Stevens, D. Eng., of Hoboken, N. J., without whose valuable assistance this paper would not have been written.]

"He made the first practical application of steam to the screw-propeller in 1804; and although the screw-propeller did not come into use until thirty-five years afterwards, his engine and screw, which are still preserved, show the correctness of his ideas, as well as the imperfection of the workmanship of that period that prevented commercial success. His short four-bladed screw has survived many forms afterwards tried.

"He patented the multi-tubular boiler in the United States, 1803; in England, 1805; established the first steam ferry in the world, between New York and Hoboken, October 11, 1811, with the 'Juliana.' (See Valentine's Annals of the City of New York).

"In 1812 (five years before the commencement of work on the Erie Canal) he addressed a memoir to the New York State Commission, urging the immediate construction of a railroad instead of a canal. This memoir with the adverse report of the Commissioners (De Witt Clinton, Gouverneur Morris, and Chancellor Livingston), was published at the time. At the date of this memoir, although railroads for carrying coal had been in use in England for upwards of two hundred years, there was not a steam locomotive or passenger car in use in the world. His plans and estimates were definite, and after the introduction of railroads their accuracy was proven."*

This pamphlet, which was entitled "Documents Tending to Prove the Superior Advantages of Railways and Steam Carriages over Canal Navigation," entitled him, even if he had failed, as he did not, in the field of invention, to be held in grateful remembrance by his countrymen for his broad and statesmanlike views, keen perception, ardent patriotism, and a demonstration that was prophetic in its accuracy.

In 1813 John Stevens designed an iron clad vessel with a "saucer-shaped" hull which was to be plated with iron and to carry a heavy battery. This vessel was designed to be secured to a swivel which was to be held in position by an anchor in the channel of the stream to be defended. Screw-propellers driven by steam engines were to be placed beneath the vessel (in order that they would be safe from injury by shot), and connected with the machinery which was arranged to cause the vessel to be rapidly revolved about the swivel in its centre. Each gun was to be fired as it was brought into line and was to be reloaded before it came around again. This was an early embodiment of the "monitor" principle. It was the first iron-clad ever designed.

The South Carolina Railroad (commenced in 1829) which when completed in 1832 was the longest railway in the world, was constructed upon his plans as laid down twenty years before.

Before 1812, in connection with his son Robert, he had made steam-boat navigation on the Delaware a commercial success. Shortly afterward he became connected with the famous Union Line, which controlled the transportation of merchandise and passengers between Philadelphia and New York for many years.

* Quotations in this and the preceding paragraphs are from the inscription on the Medallion Portrait of John Stevens in the U. S. National Museum, Washington.

Colonel Stevens was anxious to put his recommendations of 1812 into practice. In 1815 he obtained a charter from the State of New Jersey "to build a railroad from the the River Delaware, near Trenton, to the River Raritan, near New Brunswick." This was undoubtedly the earliest railroad charter granted in America; but no tangible result followed, because the scheme was regarded as wild and visionary. The introduction of the steam-boat, coupled with the success of the Duke of Bridgewater in the introduction of canals abroad, had made them more popular with capitalists than the untried railroad, and no money could be raised for that undertaking.

FIRST CHARTER OF THE PENNSYLVANIA RAILROAD.

His interest in the subject of internal communication did not flag on account of this failure, for in 1823, through his exertion, acts were passed by the Legislature of Pennsylvania for the incorporation of "The President, Directors and Company of the Pennsylvania Railroad Company" "to make, erect and establish a railroad on the route laid out (from Philadelphia to Columbia, in Lancaster county,) to be constructed on the plan and under the superintendence and direction of the said John Stevens" * Among the incorporators were Stephen Girard and Horace Binney.

Three years later (1826) Colonel Stevens, then seventy-six years old, constructed at his own expense, a locomotive with a multi-tubular boiler, which he operated for several years on a circular track on his estate at Hoboken, carrying half a dozen people at a speed of over 12 miles an hour. A model of this locomotive together with the original multi-tubular boiler which formed a part of it, is preserved in the U. S. National Museum. This was the first locomotive in America driven by steam upon a track of which there is reliable record.

He died March 6, 1838, aged 89 years. He saw the first steam engine erected on the Western Continent, at Belleville, N. J. During his lifetime Watt perfected the stationary low pressure condensing steam engine. Within his memory the Duke of Bridgewater inaugurated the canal system of Great Britain: Trevithick developed the high pressure steam engine into a commercial success and successfully applied it to the locomotive: Nelson won the Naval battle of Trafalgar: Fulton introduced steam navigation on the Hudson—steam-boats began to ply on the Mississippi and the Lakes: Captain Rogers made the first experimental steam voyage across the Atlantic with the "Savannah:" Steam was introduced into all the principal navies of the world: George and Robert Stephenson made their fame as locomotive constructors, and the railway systems at home and abroad were organized. Seven years before his death the locomotive was put upon the Camden and Amboy Railway connecting New York and Philadelphia, and on the first links of the Pennsylvania Railroad, in advocating the construction of both of which railroads he took an active part twenty years before. On the day of his death the

* See Sec. 6, p. 252, Laws of Pennsylvania 1823.

"Great Western" lay in the Thames receiving her finishing touches preparatory to making the initial voyage of the pioneer Trans-Atlantic steamship line between England and New York.

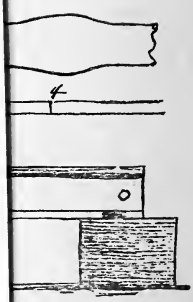
He was the copatriot of Washington—during the New Jersey campaigns: the correspondent of Barlow and Franklin: Chancellor Livingston (after whom his second son was named) was his brother-in-law: and although he was the rival of Fulton in introducing the steam-boat in America, they had been warm friends for several years before the latter's death in 1815.

Charles King, President of the Columbia College, writing of him in 1852 says: "Born to affluence, his whole life was devoted to experiments, at his own cost, for the common good. He was a thoroughly excited and an unwearied experimenter in the application of steam to locomotion on the water, and subsequently on the land. Time has vindicated his claim to the character of a far-seeing, accurate, and skillful, practical experimentalist and inventor. The thinker was ahead of his age."

The careers of the sons are closely interwoven with his.

ROBERT LIVINGSTON STEVENS.

Robert Livingston Stevens was born October 18, 1787. In 1804 he assisted his father in the construction of the first twin screw steam-boat, being then only seventeen years old. He took the "Phœnix" from New York to Philadelphia by sea in June, 1808. The "Phœnix" was the first steam-boat to navigate the ocean. At the death of Fulton, 1815, the speed of steam-boats on the Hudson was under 7 miles an hour. The "Philadelphia", built by Robert L. Stevens, had a speed of 8 miles. He succeeded in increasing the speed of each successive steam-boat of the many that he built until in 1832 the "North America", the finest boat of her time, attained 15 miles. For 25 years after 1815 he stood at the head of his profession as a constructer of steam-vessels. In 1821 he originated the form of ferry-boats and ferry-slips, now in general use, constructing the ferry-slips with spring piling and fenders. In 1818 he invented the cam board cut off, and applied it to the steam-boat "Philadelphia," on the Delaware: this being the first application of the expansive action of steam to navigation..—In 1821 he adopted the working (or walking beam) and improved it by making it of wrought iron strap with a cast iron centre: in 1829 he adopted the shape now universally used in this country He invented the split water wheel in 1826, and in 1831 the balance-valve, which is now always used on the beam engine. He first placed the boilers on the wheel-guards over the water: he adopted the Stevens' cut off, and finally left the American working beam (or walking beam) engine in its present form. Beginning with a pressure of 2 pounds to the square inch he increased the strength of his boilers until 50 pounds could be safely carried. He made the first marine tubular boiler in 1831. He reduced the vibration of the hull and added greatly to the strength by the overhead truss frame of masts and rods now used.



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Early in October, 1830, and shortly after the surveys of the Camden and Amboy Railroad were completed, Robert L. Stevens, who was President and Chief Engineer of that road, sailed for England to order a locomotive and iron rails. At that time no rolling mill in America could roll T rails.

Robert Stevens advocated the use of an all iron rail in preference to the wooden rail or stone stringer plated with strap iron, then in use on one or two short American railroads. At his suggestion the Board of Directors of the Camden and Amboy railroad passed a special resolution authorizing him to obtain the rails he advocated.

During the voyage to Liverpool he whiled away the hours on shipboard by whittling thin wood into shapes of imaginary rail-sections until he finally decided which one was best suited to the needs of the new road.

He was familiar with the Birkenshaw rail with which the best English roads were then being laid, but he saw that, as it required an expensive chair to hold it in place, it was not adapted to our Country, where metal workers were scarce and iron was dear. He added the base to the T rail, (see plate—fac-simile of Specification—Nov. 26, 1830) dispensing with the chair. He also designed the "hook-headed" spike(which is substantially the railroad spike of to-day) and the "iron tongue", (which has been developed into the fish-bar), and the bolts and nuts to complete the joint.

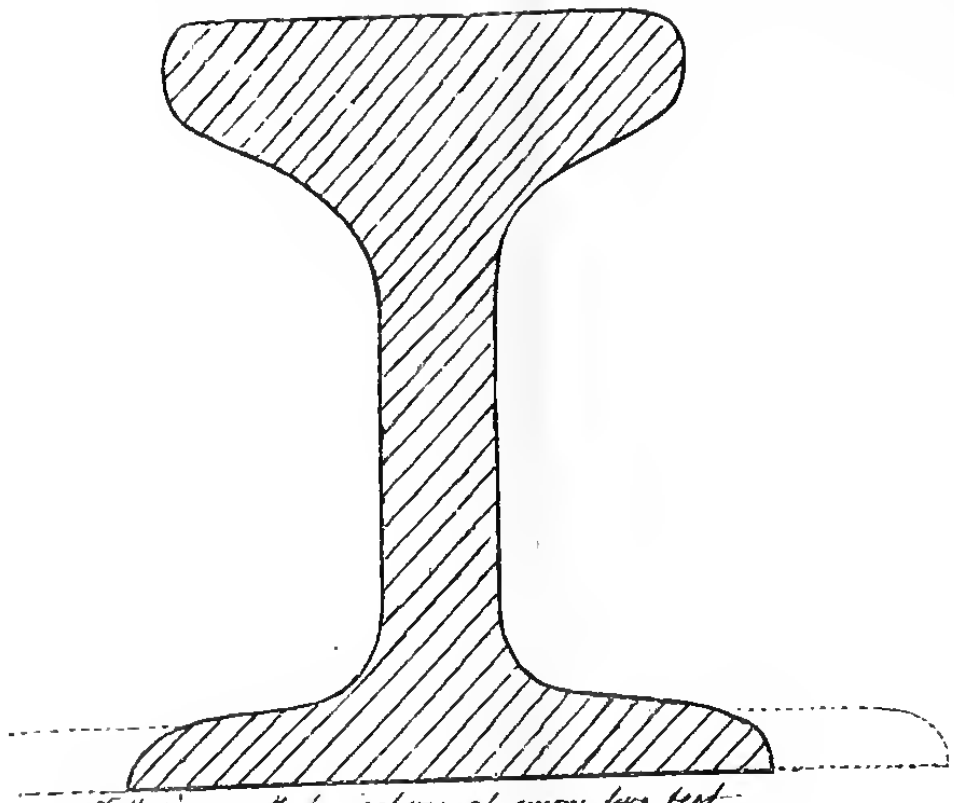
Mr. Stevens neglected to obtain a patent for these inventions, although urged to do so by Mr. F. B. Ogden, American Consul at Liverpool, and the credit of being the inventor of the American Rail was for a time claimed for others, but the evidence * brought forward in late years fully establishes the fact that he was the originator of the American system of railway construction. The "Stevens rail" gradually found favor in America—all roads being relaid with it as the original T or strap rail became worn out.

Sixty years have elapsed since this rail was adopted by the Camden and Amboy Company, and with the exception of slight alterations in the proportions incident to increased weight, no radical change has been made in the "Stevens rail," which is now in use on every railroad in America. Many improvements have been made in the joint fixture but the "tongue" or fish plate improved into the angle splice bar is in general use, and nothing has yet been found to take the place of the "hook-headed" railroad spike which Robert Stevens then designed.

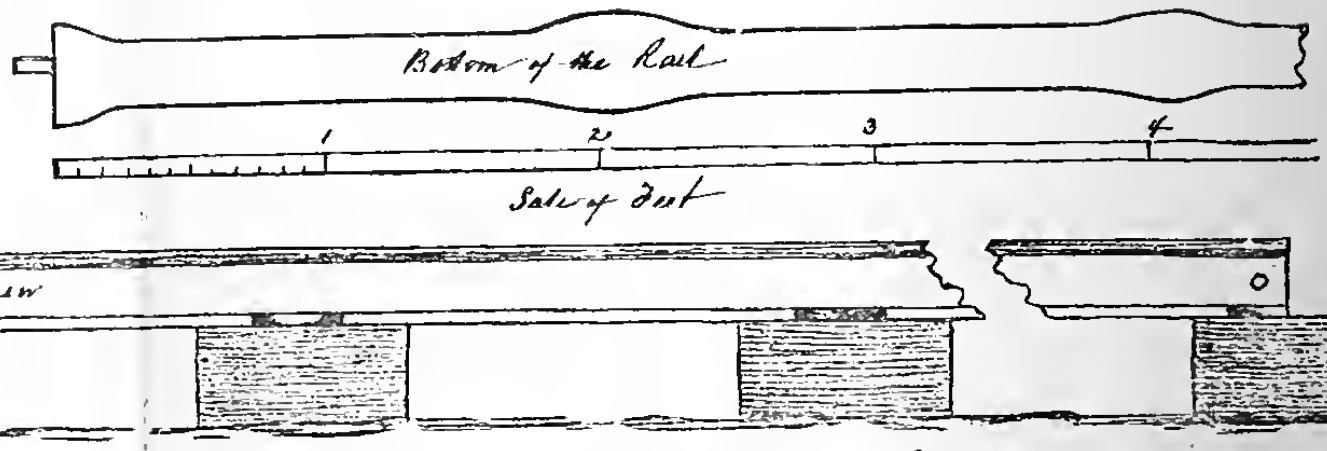
Mr. Stevens divided his time while abroad between arranging for the manufacture of track material and examining the English locomotives that were being constructed or had been in service.

A year had elapsed since the opening of the Liverpool and Manchester Railway, and the English mechanics had not been idle. The "Rocket,"

* On July 16, 1831 Mr. Ogden wrote Mr. Stevens from Liverpool as follows:
"The price of iron remains about the same as when you were here and I do not think there would be much difference in any future contract. It would make considerable however if you would have the rails of unequal lengths, say from 10 to 16 feet, and it appears to me to be of little importance that the joints should always be opposite to each other. Vignoles has laid down his road in that way, the rail remarkably well executed on *your pattern*. (like the pieces I sent out to you) but made lighter and is very much pleased with it and says it is decidedly the best rail in use."



Full size with projections at every two feet on the bottom flange. 3/4 of an inch by 4 inches.



Liverpool November 26 1830.

Gentlemen

At what rate will you contract to deliver at Liverpool; say from five to six hundred tons of Railway of the best quality Iron rolled to the above pattern in twelve or fourteen feet lengths, to lap as shewn in the drawing, with one hole at each end, and the projections on the lower flange at every two feet. Cash on delivery. How soon could you make the first delivery, and at what rate per month until the whole is complete. Should the terms suit and the work give satisfaction a more extended order is likely to follow, as this is but about one sixth part of the quantity required. Please to address your answer (as soon as convenient) to the care of Francis B Ogden, Consul of the United States at Liverpool.

I am

Your obedient Servant

Robt L Stevens

President & Engineer of the Camden & South Amboy Railroad & transportation Company

although successful in the Rainhill contest, when put to work had shown many defects that Stephenson & Co. were striving to correct in subsequent locomotives.

The "Planet," built by that firm, was first tried in public December 4, 1830, shortly after Mr. Stevens arrived in England, and at that time was undoubtedly the best locomotive in the world.

Mr. Stevens was present at a trial when the "Planet" showed most satisfactory properties. and he at once ordered a locomotive of similar construction, from the same manufacturers. This locomotive called the "John Bull," put in service in 1831, is the prototype of the locomotive now in general use. It is now preserved at the U. S. National Museum.

Toward the close of the War of 1812 Robert L. Stevens was engaged in making a bomb that could be fired from a cannon instead of from a mortar, in order that it might be applied to naval warfare. * He succeeded in producing a successful percussion shell, which was adopted by the U. S. Government who purchased a large quantity together with the secret of its construction.

In 1850 he designed and built the "Maria," the fastest sailing vesssel of her day. This was the yacht that defeated the "America" in New York harbor a few months before the lattter won the memorable race on the "Solent." It was in this race that her Majesty Queen Victoria, when she asked her favorite skipper who was first and second in the race received for a reply "The 'America' leads, there is no second."

Many years before the laws governing the variation of resistance of vessels driven at excessive speeds were generally understood Robert L. Stevens had not only arrived at a knowledge of them but had put into practice those forms of least resistance—the graceful water lines which now distinguish the practice of the modern naval architects.

He died at Hoboken April 20, 1856.

Robert L. Stevens will be remembered as the greatest American mechanical engineer of his day—a most intelligent naval architect—to whom the World is indebted for the commencement of the mightiest revolution in the methods of modern naval warfare.

EDWIN AUGUSTUS STEVENS.

Edwin A. Stevens, the seventh son of Col. John Stevens, was born at Castle Point, Hoboken, July 28th, 1795.

He received his engineering education from his father, and from his brother Robert L., his senior by eight years, and with whom he was associated in business partnership from his early manhood. On this account the individual work of the two brothers cannot always be separated, but it may be said that while both were men of great capacity as engineers and business men, the elder took the lead as an engineer, and the younger as a business man.

* As it is impossible to separate the individual labors of the brothers upon armored ships, this portion of their biographies is appended under "The Joint Work of Robert L. and Edwin A. Stevens in the introduction of Armor on Ships of War."

The laborious and useful life of Edwin A. Stevens was occupied in the life-long management of his father's estate, on which the City of Hoboken now stands: in the organization, construction and operation of the Camden and Amboy Railroad, of which he was the active business manager: in making improvements in steam navigation: in the great part taken by him in the introduction of iron armor on ships of war: and in devising methods of attack and defence for iron clads.

At the age of twenty-five, by a family agreement, he was made trustee of the greater portion of his father's estate, including what was then the island, but which has since become the City of Hoboken, thus relieving his father, then seventy years of age, of the burden of his business cares. He remained at Hoboken until he was about thirty, taking care of the estate and assisting both his father and his brother, Robert, in their engineering labors. During that period he invented and patented the Stevens plough, which was much liked and extensively used for years. This gave him an extended acquaintance among the land owners of New Jersey that lasted for many years.

In the latter part of the year 1825, at the age of thirty, he took charge of the Union Line, which then carried nearly all the passengers and freight between New York and Philadelphia. The Union Line was organized in 1820, and it consisted of steam-boats on the Raritan and Delaware, and of coaches on the turnpike between Trenton and New Brunswick. And after the year 1827, it was chiefly owned by the brothers Robert L., Edwin A. and John C. Stevens, Edwin remaining its business manager until it was merged into the Camden and Amboy Railroad in 1832. The coaching of the Union Line surpassed anything of the kind ever known in the United States. Long trains of four horse coaches, at times amounting to thirty or forty daily awaited in line, the arrival of the steam-boats at each end of the turnpike, and were then drawn rapidly, frequently on a gallop across the state. The coaches were lighter than the English coach; they were limited to ten passengers each, and many of the horses were thoroughbred.

The Camden and Amboy Railroad was chartered in 1830, when Robert L. Stevens was made President and Engineer, and his brother Edwin, Treasurer and Manager; and the great business capacity of the latter was then shown by the speedy organization of the company and the construction of the road. He gathered around him as associates in the company the ablest lawyers of the state, by which means a timely settlement was made of the legal questions raised against privileges necessary for a railroad, but antagonistic to what was then considered the common law of highways. And he selected for the work to be done, the best available business men, mechanics and contractors: the result being the incredibly short time in which the legal objections were met, the right of way secured and the road built and put in operation.

He remained the business manager of the Camden and Amboy Railroad for upwards of thirty-five years, during which time the stock constantly appreciated in value, and no dividend was passed.

It was within this period that the American railroad system was developed, differing very materially from that simultaneously developed in England, and on the Continent of Europe—First; in the adoption of means of running safely on tracks not inclosed. Secondly; in the alteration of the form of passenger coaches, so as to have intercommunication between them. Thirdly; in the greater simplicity and hardihood of the locomotive. Fourthly; in the increased weight and strength of the rolling stock. And Fifthly; in a better system of carrying both passengers and freight.

In the developement of this American system Robert and Edwin Stevens were prominent. As engineers they invented and constructed many of the countless appliances found necessary; and as business men they adopted those introduced on other railroads.

During the time when his sons were being educated, Colonel Stevens resided in the Summer at Castle Point, Hoboken, and they were obliged to cross the Hudson to school and college by sail or row boats, then the only means of transit. This early experience on the water added to and directed the interest they took in after life in the improvement in steam navigation, and it also led to their becoming devoted yachtmen. Edwin was in his boyhood, when his brother Robert made his early improvements in steam navigation, but after he grew up he greatly assisted his brother. The most notable of his individual improvements was the air-tight fire room, patented by him April, 1842, (No. 2,524,) and now in use in all the navies of the world.

He died in Paris, France, in 1868.

By his will he endowed the Stevens Institute, Hoboken: the earliest, or among the earliest, of the technological colleges that have proved so useful.

JOINT WORK OF ROBERT L. AND EDWIN A. STEVENS IN THE INTRODUCTION OF ARMOR ON SHIPS OF WAR.

In the year 1814, and towards the close of our last war with Great Britain, Colonel Stevens had projected the circular iron fort moved by steam, previously alluded to, for the harbor of New York, and by his direction his son Edwin, then nineteen years of age, experimented with a six pounder bronze cannon fired against iron plating. This cannon is still retained at Castle Point. Iron armor, for the protection of the person, has been in use from prehistoric ages, but the demonstration that it could be applied to ships of war was made for the first time by Edwin A. Stevens in 1841, twenty-seven years after he had made the experiments for his father, and at the time when we were on the very brink of war with Great Britain, on account of aggressions on our Canadian frontier. As thick armor plate could not be made at that date, he devised a method of armor plating in laminæ, or of plates laid over each other and riveted. He then made a series of experiments to determine the thickness of plating required to resist the different sizes of balls then in use. From these experiments which were made at Bordentown, New Jersey, in the Summer of 1841, he made the deduction that a target of iron 4½ inches

thick, would resist a 64 pound shot, at that time the heaviest ball used in our navy. With the assistance of his brother John C., (his brother Robert being then in Europe) he laid the results of his experiments before President Tyler. As the whole country was then aroused, the President immediately appointed a joint board composed of the ablest ordnance officers of the army, and of the leading officers of the navy to superintend the experiments of the Messrs. Stevens, on iron as a protection for war vessels, and in compliance with the request of this joint board John C. and Edwin A. Stevens wrote them a letter giving their views upon the subject of steamers for coast and harbor defense, stating that their ideas were principally derived from their brother Robert L. Stevens, then abroad. This letter, written August 13th, 1841, and before the application of the screw to vessels of war, can be said to embody the leading principles of naval warfare that have since been reduced to practice.

The army officers were Colonels Totten, Thayer and Talcott, and the naval ones Commodores Stewart, Perry and Smith. The targets 4½ inches thick made by Edwin A. Stevens were tested at Sandy Hook by the joint board of officers in the months of September, October and November, 1841. They made an elaborate report, unanimously agreeing that the targets fully withstood the numerous shots from the heaviest guns then in the service. It was upon the presentation of this report by the Naval Committees of the Senate and the House of Representatives that the act of Congress was passed, authorizing the Secretary of the Navy to contract with Robert L. Stevens, who had then just returned from Europe, for an iron clad steamer, to be "shot and shell proof." The Act is as follows :

Chapter XII, (statutes of the United States at Large) April 14th, 1842, An Act authorizing the construction of a steamer for harbor defense.

Be it enacted by the Senate and House of Representatives of the United States of America, that the Secretary of the Navy is hereby authorized to enter into contract with Robert L. Stevens for the construction of a war steamer, shot and shell proof, to be built principally of iron, upon the plan of said Stevens. Provided, the whole cost, including hull, armament, engines, boilers, and equipment, in all respects complete for service, shall not exceed the average cost of the steamers Missouri and Mississippi, and be it further enacted, that two hundred and fifty thousand dollars ($250,000), be, and the same is hereby appropriated out of any money in the Treasury not otherwise appropriated toward carrying this law into effect.

(Approved by the President of the United States) JOHN TYLER.

It may be mentioned that this bill was reported from the Committee of the whole of the House of Representatives, April 7th, 1842, at the suggestion of Ex-President John Quincy Adams, then a member of the House, who characterized it as "One of pressing emergency." It passed the Senate unanimously, and in the House there were but thirteen dissenting votes.

Upon the passage of the Act, Robert, with the assistance of his brother Edwin, commenced immediately to plan and construct the vessel. He built a dry-dock for it at Hoboken, and proceeded rapidly with the work.

At the date of the passage of this Act of Congress there had been but little change in the power of guns from those used by Nelson at the battle of Trafalgar in 1805, or on our frigates in the war of 1812. But when Commmodore R. F. Stockton after the failure of his first gun, February 28th, 1844, succeeded in having constructed in England, a wrought iron gun throwing a round shot, that pierced a target 4½ inches thick, Robert Stevens altered his plans, increasing the thickness of the armor, and the size of the vessel that he had contracted to build "shot and shell proof," and then began in the great navies of the World, the long drawn out battle between gun and armor, a contest that by the intervention of other methods, may never be decided. When more powerful guns were introduced, either at home or abroad, other alterations were made thus causing interminable interruptions of the work, many long delays, and an increase of expenditures far beyond that provided for by the Act of Congress. Dying in 1856, five years before our Civil War, he left the vessel unfinished in the basin at Hoboken, but with all the plating on and with the twin-screw engines and the boilers, having 876 square feet of grate surface, in their positions.

This vessel was 410 feet long, 45 feet beam inside of the armor shelf, with the deck two feet above the water, and was similar in these respects to the Monitor class of vessels built six years afterwards by Ericsson, but differing in having a square and immovable turret, instead of a circular and movable one.

During the Crimean War, in 1855, the French Government built three small vessels protected by thin armor, this being the first use of iron clads in naval warfare.

It is significant that on the "Warrior," the first English iron clad, and on the French Frigate "Gloire," both built in 1860, eighteen years after the demonstration of Edwin A. Stevens at Sandy Hook, and on the "Monitor," built in 1862, the thickness of the armor adopted was that of his targets: namely, four and a-half inches

At the commencement of our Civil War, and twenty years after his demonstration at Sandy Hook that a vessel could be protected by iron armor, Edwin Stevens presented to the Government a plan for completing the "Stevens Battery" (which had been bequeathed to him by his brother Robert,) together with a small vessel called the "Naugatuck," to demonstrate the practicability of his plans. This small vessel was accepted by the Government and was one of the fleet that attacked the "Merrimac." She was a twin-screw vessel, capable of being immersed 3 feet below her load line, so as to be nearly invisible, and of being raised again in 8 minutes by pumping out the immersing weight of the water, and of turning end for end on her centre in one minute and a quarter. As the plans for the modification of the Stevens Battery embodied ideas then novel, but which have since been found practicable and

necessary, his offer was rejected by the Government. The "Stevens Battery" remained in the same state in which it was left at the death of Robert, in 1856, until after the death of Edwin, in 1868. The latter bequeathed it to the State of New Jersey, together with one million dollars for its completion. This money was spent in 1869 and 1870. The vessel was never launched, and in 1881 was taken to pieces and sold for old material.

It may be truly said that through the labors of John Stevens and his sons in the field of experimental mechanics they were able to determine important engineering constants, of incalculable value to the marine, civil and military engineer.

Their greatest achievement was to obtain definite information relating to the economics of engineering in the broadest sense.

Familiar with the theory of machines, as understood in their day, they were untiring in the practical demonstration of the problems presented to their attention.

The laws which they investigated and the facts they placed upon record are now so well understood that few know, or remember, that it is to the Stevenses that we are indebted for most valuable data used in modern practice by the engineer of to-day.

It is to be regretted that no comprehensive biography of the Stevens family is accessible to the student of engineering history.